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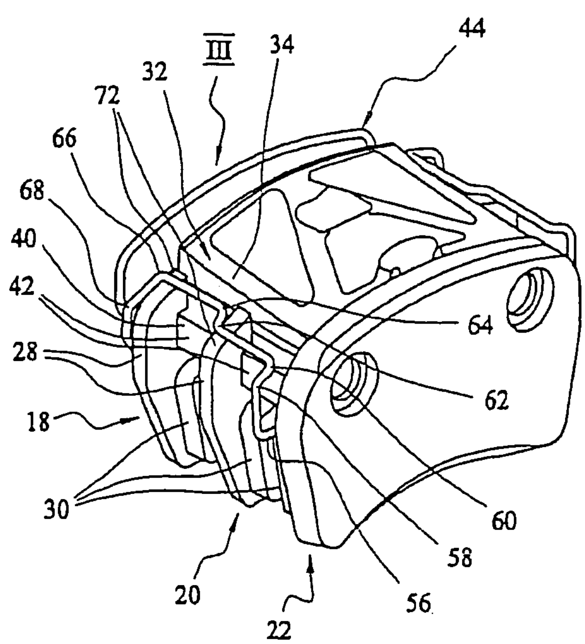
(54) Title: APPARATUS AND METHOD FOR MOUNTING FRICTION ELEMENTS IN DISC BRAKES



(57) Abstract: Spot-type automotive disc brake (10) of floating-twin disc and fixed-caliper format. Utilises one or more single wire springs (44) as resilient means to bias the two floating friction elements (18, 20) with respect to the fixed caliper (34). Each spring exerts a differential resilient effect on the central friction element (20) with respect to the floating side friction element (18) by virtue of differential connection arrangements, thereby meeting the differential springing requirements.

WO 01/86165 A1

APPARATUS AND METHOD FOR MOUNTING FRICTION ELEMENTS IN DISC BRAKES

This invention relates to a method and apparatus for mounting friction elements in disc brakes. A particular embodiment of the invention relates to the mounting of friction elements in a disc brake of the kind in which at least one brake disc is axially slidable with respect to its associated rotatable mounting and the friction elements which frictionally engage braking surfaces at opposite sides of the disc are slidably mounted on a fixed caliper or bridge structure which resists movement of the friction elements under the action of the frictional forces generated by engagement of same with the rotating brake disc during actuation of the brake. Certain aspects of the invention may find wider application than strictly in relation to a disc brake of the kind just enumerated.

There is disclosed in WO 98/26192 (docket 2558) and WO 98/25804 (docket 2561) a disc brake of the kind described above in which resilient means is provided in relation to at least one axially slidable brake disc and in relation to at least one axially slidable friction element. The resilient means for the disc provides, inter-alia, an anti-tilt mounting function. The resilient means for the friction element serves merely to prevent rattle.

In our above-identified prior published WO specifications, the arrangement adopted in relation to the friction elements for mounting the resilient means with respect to the fixed caliper or bridge structure has been on the basis of using the fixed and stable structure of the caliper or bridge as a mounting for providing the basis or foundation

from which the resilient means takes its mounting for exerting the necessary forces on the friction elements. Such an arrangement has been considered a logical basis for the construction of an assembly in which there is a need for a high degree of structural and operational integrity achievable on the basis of, inter alia, simplicity of structure and assembly, and minimisation of mechanical wear in use, and related factors.

In the embodiments of these prior proposals there has been adopted the use of a leaf-type spring acting from the caliper or bridge, and mounted thereon by means of fasteners, and a suitable connection to the friction elements accordingly.

One aspect of the construction of springing systems for the friction elements of spot type disc brakes employing one or more axially floating discs, concerns the matching of the spring effect to the physical characteristics of the friction element concerned, notably the question of whether or not the friction element is double-sided (as occurs in the case of the central friction element between a pair of floating brake discs in a double-disc brake of this kind). There may be other circumstances in which it is desirable to vary the spring force applied to the friction element as between one such friction element and another. In the case of a central friction element between a pair of floating brake discs, the actual construction of the friction element (which affects its mass and inertia) differs from that of its associated single-sided friction elements on the outer side of each of the two brake discs. Likewise, it will be understood, that in addition to the static factors affecting such a friction element, so too the dynamic factors affecting it differ from those of its single-sided

neighbours in that the double-sided frictional effects during actuation of the brake differ very substantially (from the single-sided effect) and lead to a requirement, we have discovered, for a differential springing effect as between the two types of friction elements accordingly.

While design or dynamic factors arising in a disc brake of the relevant kind may produce a requirement for a differential springing effect even in relation to a brake having a single sliding disc, as disclosed below and as is likely to be the case commercially, the more usual brake structure comprises at least two discs with a double-sided friction element slidingly mounted between the discs, and which is subjected to significantly different forces from those applied to its single-sided neighbour (on the piston-and-cylinder actuator side of the brake), and these differences lead to a requirement for the above-discussed differential springing effect.

Further related factors which have influenced the basis for the technical advance incorporated in the embodiments of the invention include the fact that our prior unpublished work in this field on the control of friction elements includes (as mentioned above) the use of leaf springs mounted on the fixed caliper of the disc brake and acting on all friction elements in an endeavour to provide the necessary spring effect in a simple structure. Such an arrangement can indeed be constructed to provide the required spring effect. However, improvements in several respects would be potentially capable of providing significant performance advantages in relation to such aspects as simplicity and cost of construction of the resilient means, simplicity of mounting (and the avoidance of the use of fasteners such as cap screws), avoidance of

the entrapment of dirt and water, and the reduction of space requirements, with the related potential benefit in relation to vehicle turning circle as affected by the volume of movement described by the brake structure in vehicle turning movements (in relation to steered wheels). A further factor relates to ability to apply the spring effect at the location on the friction element where such is of best effect and preferably in a symmetrical manner, for example at both lateral sides of the friction element where it is mounted on guides for sliding movement towards and away from (at least in terms of relative movement) the associated disc friction surfaces.

It needs also to be noted that the resilient means adopted in the embodiments of the present invention have a resilient effect and generate a corresponding spring force which is of a magnitude such that it is significantly greater than that which is required merely for elimination of rattle, and a distinction is, therefore to be drawn between the resilient means of the embodiments of the present invention and previously proposed anti-rattle springs in brakes of various kinds. The spring forces generated in the embodiments of the present invention are at a level such that the friction elements are constrained (by the predetermined spring forces) from sliding on their guides, whereby not only is rattling or noise suppression achieved but also the friction elements are restrained from free sliding movement into contact with the brake discs in an uncontrolled manner.

According to the invention there is provided a method and corresponding apparatus as set forth in the accompanying claims.

In described embodiments of the invention, resilient means is provided by the two or more friction elements which are slidably mounted in a disc brake and the resilient means acts on both such friction elements so as to produce a differential resilient effect as between the two friction elements, whereby the resilient effect can be matched to the physical characteristics, including mountings, of the friction elements themselves.

In the described embodiments, the resilient means is adopted in a wire spring format which enables several significant advantages to be achieved, including simplicity of mounting (by means of cooperation between the wire of the spring and suitable drillings or bores or notches in the friction elements). Moreover the wire spring form conveniently enables the springs to incorporate various chosen profiles achieved by bending, whereby the location and geometry of the spring and its connection to the friction elements enables the required differential effect to be achieved. For example one simple way of effecting this is to arrange matters so that the moment of the forces exerted by the spring in relation to the friction element is varied in accordance with the required spring effect either by choosing the length of the moment arm accordingly and/or connecting the spring to the friction element appropriately.

Another aspect of the resilient means in the embodiment, which leads to practical advantages in relation to the general construction of the wire spring which provides the required resilient properties, is that a one-piece construction can be adopted which has a generally channel-shape profile as seen in its operating attitude in plan view and thus the wire spring is able to straddle the

opposite sides of the caliper or bridge structure which supports the friction elements in their sliding movement. It will be understood that the adoption of a single wire spring construction enables the differing spring forces required by the friction elements to be applied at opposite ends of each of these. Moreover the spring construction has the inherent simplicity of a wire spring, and is coupled with the easy mounting of same as discussed above. Also the spring has the ability to extend between the spaced friction elements for actuation of each and the wire construction has an inherent tendency not to provide structures offering a trap for foreign matter and debris. In this way there has been provided a spring system for friction element mounting in brakes of the relevant kind which offers significant technical advances.

In the embodiments of the present invention the disc brake incorporates resilient means both in relation to the mounting of the brake discs on their mounting hub and in relation to the brake friction elements or pads in relation to their fixed mounting or caliper.

The resilient means are of a structure and strength chosen to be capable of, both in the case of the brake disc and in the case of the brake friction elements, maintaining these components of the brake assembly in their required working attitudes with respect to the structures on which they are mounted. In other words, the springs or resilient means for the brake discs are constructed so as to hold the brake discs in non-tilted working attitudes as they rotate. Likewise, the resilient means for the friction elements or pads maintain these latter structures in their required attitudes with respect to their fixed mounting or caliper. In both cases, the resilient nature of the resilient means

permits under the dynamic conditions arising during use of the vehicle and due to engine vibration and vehicle motion/road surface induced vibration and similar factors, a degree of movement from the defined working position (as opposed to the linear axial sliding movement needed to effect friction element-to-disc engagement and disengagement when commencing and terminating braking) which is needed under normal conditions of vehicle use.

In this regard, it is to be noted that the resilient means or springs used in the embodiments in relation to the friction elements for maintaining same in their normal untilted attitudes, differ significantly from the springs disclosed in the above-identified WO 98/25804 and WO 98/26192 specifications in which the pad springs are mere anti-rattle springs not adapted to hold the brake pads against tilting movement, but merely to avoid rattling. Moreover, in the embodiments of the present invention the springs for the discs and for the pads are balanced in terms of their relative loading applied to the discs and the pads in order to achieve the necessary separation of same when braking is discontinued and yet holding the pads and discs against tilting during use. Thus, the spring forces exerted on the pads or friction elements of the present invention are much stronger than those merely to prevent rattling or noise suppression. The spring forces are sufficient to restrain the slidable brake pads or friction elements from moving into contact with the brake discs in an uncontrolled manner. The use of the substantially stronger pad springs in the present embodiment assists in positioning the outer rims of the brake discs in their brake-off position for reducing residual brake torque.

Embodiments of the invention will now be described by reference of the accompanying drawings in which:

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 shows in block diagram format a spot-type automotive disc brake comprising a pair of axially slidable discs and associated friction elements, an actuating mechanism therefor and a fixed caliper or bridge structure overlying same;

Figures 2 to 5 show views of a first embodiment of the invention which is applicable to a disc brake of the kind shown in Fig 1, Fig 2 being a perspective view of the caliper assembly which includes a central friction element and two side or end friction elements, and Figs 3, 4 and 5 being views of the resilient means or spring, on its own, as seen generally in the directions indicated in Figs 2 and 3 by arrows III, IV and V respectively;

Figures 6 to 9 show a second embodiment of the invention which is likewise applicable to a disc brake of the kind shown in Fig 1, Fig 6 being a perspective view similar to that of Fig 2 but showing a different form of spring and mounting which is adapted to act at one side only of the assembly of three friction elements, Fig 7 being a side elevation view of the spring as seen in the direction of arrow VIII in Fig 6, and on a somewhat larger scale;

and

Figures 8 and 9 being further views of the spring of Fig 7, as viewed in the direction of arrows VIII and IX in Fig 7.

As shown in Fig 1 a spot-type automotive disc brake 10 comprises a pair of rotatable brake discs 12, 14, a rotatable mounting 16 for the brake discs to permit rotation of the discs and which is adapted to drive the brake discs and have exerted thereon the braking effect by the discs when the disc brake 10 is actuated.

Two pairs of friction elements 18, 20 and 20, 22 are provided and are adapted to frictionally engage braking surfaces 24, 26 provided at opposite sides of brake discs 12, 14 to effect braking on actuating actuation means for the brake. Central friction element 20 is double-sided for frictional engagement with the mutually-inwardly facing braking surfaces 24, 26 of brake discs 12, 14 and is provided with appropriately facing friction pad material accordingly. Friction elements 18, 20, 22 comprise (as shown in Figs 2 and 6) in each case a generally flat metal backing plate 28 and secured thereto and standing proud thereof a body of friction material 30 of known construction for high durability frictional engagement with the relevant braking surface of the relevant brake disc. In the case of central friction element 20, the friction material is provided at both faces of the backing plate 28.

Brake discs 12, 14 are axially slidable in use with respect to their rotatable mounting 16 under the action of friction elements 18, 20, 22 and the actuation means (to be described below) therefor during braking. For example the

brake discs may be keyed to the rotatable mounting or hub 16 at three or more locations and resilient means may act there between. We refer to the disclosure in our co-pending application number GB******(our reference P54615GB) and incorporate the relevant portion of the disclosure therein herein by reference accordingly.

A fixed non-rotatable mounting 32 for friction elements 18, 20,22 is provided comprising a caliper or bridge structure 34 which is mounted on a fixed structure of the vehicle to be braked, for example on the wheel mounting and which straddles the brake discs 12, 14 and also provides a mounting for actuation means 36,38 (indicated diagrammatically) which applies inwardly directed braking forces to the outer friction elements 18, 22, thereby causing frictional engagement with the brake discs 12, 14 and slight sliding movement of those discs with respect to their rotatable mounting 16. In Fig 1 of course it can be seen that the clearances between the structures have been greatly exaggerated for simplicity of diagrammatic illustration. The actuation means 36, 38 could comprise a pair of piston and cylinder assemblies. However only one such is strictly needed since the actuation means can be one-sided with a fixed structure at one side or the other of the assembly of discs and friction elements (which fixed structure could simply be a stop extending from caliper 34), and against which fixed structure the assembly is pushed by the single actuation means. Further details in this regard may be found in our co-pending applications GB9928162.8 (our reference P54532GB) and GB9926022.6 our reference P54534GB)

Fixed and non-rotatable mounting 32 for the friction elements 18 to 22 is adapted permit sliding movement of the

friction elements into and out of frictional engagement with the brake discs while resisting rotational movement of the friction elements under the action of frictional forces generated by engagement of the friction elements with the discs 12, 14. As shown in Figs 2 and 6 the friction elements are slidably mounted on the caliper 34 by means of a pair of laterally-facing guide rails 40 provided one at each side of the caliper 34, and complementarily-shaped groves formed in the friction element backing plates 28 whereby these latter are freely smilingly moveable on the rails 40, with a minimum of clearance or backlash, having regard to acceptable manufacturing tolerances.

Resilient means 44 is provided in relation to the non-rotatable mounting 32 for the friction elements 18 to 22 and is adapted to act between the friction elements (at the opposite sides of the brake discs) and caliper 34 in order to minimise friction element movement in the brakes-off condition and/or noise and/or rattle with respect to the caliper or bridge 34 (and generally in a direction laterally with respect to the direction of inward movement of the friction element to engage the brake discs on commencing braking), as will be more fully described below.

Turning now the construction of resilient means 44, in the embodiment of Figs 2 to 5, this is adapted to act on all three friction elements 18, 20, 22 and so as to exert a differential spring effect as between the central one 20 of these and the other two friction elements 18, 22, by virtue of differential physical characteristics in the connection of the resilient means to the friction element 20 and to the friction elements 18, 22 accordingly.

As will be explained below, resilient means 44 is

constructed and arranged so as to exert its differential spring effect on the friction elements 18, 20, 22 by being connected to these at different locations on the friction elements at which the resilient means generates different levels of force. Moreover the resilient means 44 is in the form of wire spring means which is caused to exert its differential spring effect by virtue of shaped portions of the wire spring in which the wire follows a non-linear profile, as more fully described below.

In this first embodiment of the invention, resilient means 44 extends generally axially with respect to the brake discs 12, 14 in axial portions 46, 48 of the resilient means (see fig 3) and has laterally-extending portions 50, 52 at the ends of the axial portions, the latter of which extends across to and is joined integrally with the other such portion 52 so as to form with a U-shaped overall spring structure which cooperates with the friction elements 18, 20, 22 at opposite (circumferentially spaced with respect to the brake disc) sides of each friction element.

It will be understood that in this embodiment of a fixed caliper/floating disc-type disc brake the actuation of the brake is in fact effected from a piston and cylinder assembly (not shown) at one side only (say actuation means 36) so that friction element 22 is simply fixed to caliper 34 and does not require to slide with respect thereto. Thus, only central friction element 20 and floating friction element 18 require the action of resilient means 44.

Accordingly, turning now to the details of the construction and arrangement of resilient means 44 in Figs 2 to 5, it

will be seen in Fig 2 that the resilient means is constructed in the form shown in Figs 3, 4 and 5 of a wire spring.

As can be seen in Fig 2, wire spring 44 engages the undersides of guide rails 40 of caliper 34 at the inner end of laterally extending portions 50 of the spring and extends via bends 56, 58, 60, 62, 64, 66 and 68 to the transverse proportion 70 which is an integral link between the laterally-extending portions 52.

Wire spring 44 acts on sliding friction elements 18, 20 at notches 72, 74, between which the wire is joggled whereby the spring force within spring 34 is applied to the friction elements at different locations thereon (with respect to guide rails 54), and indeed at different portions of the spring which have differing geometry with respect to the overall spring structure and thus themselves give rise to a differential spring effect.

In the embodiment of Figs 6 to 9, the general construction of the caliper assembly is similar to that of the preceding embodiment. In Fig 6, the direction of viewing is different from that of Fig 2, the caliper assembly being viewed from the actuation side, looking towards the fixed friction element 22, item 76 being a housing for the hydraulic actuator assembly. In this embodiment, instead of providing a single spring assembly joined by transverse portion 70 as in the embodiment of Figs 2 to 5, a pair of springs 78 are provided one associated with each of the guide rails 40 and which are located by an end spigot 80 which locates in a bore in fixed friction element 22, the other end of each spring 78 engaging the underside of guide rails 40, as in the preceding embodiment, and the spring engaging in

notches 72, 74 formed in the friction elements in a manner similar to that of the preceding embodiment.

It will be noted that in both of the above embodiments, the resilient means 44 are constructed to be able to accommodate the limited axial sliding movement of the friction elements with respect to the caliper 34 in use by means of sliding movement of the friction elements with respect to linear portions of the wire spring elements.

CLAIMS

1. A method of mounting a friction element in a spot-type automotive disc brake, the disc brake comprising:-

a) at least one rotatable brake disc;

b) a rotatable mounting for said brake disc to permit such rotation and which is adapted to drive said brake disc and to have exerted thereon a braking effect by said brake disc when the disc brake is actuated;

c) at least one pair of friction elements adapted to frictionally engage braking surfaces on opposite sides of said brake disc to effect braking on actuation of actuation means therefor;

d) said brake disc being axially slidable in use with respect to said mounting therefor under the action of said friction elements and said actuation means therefor during braking;

e) a non-rotatable mounting for said friction elements adapted to permit sliding movement of same into and out of frictional engagement with said disc while resisting movement of same under the action of frictional forces generated by engagement of same with said discs;

f) resilient means being provided in relation to said non-rotatable mounting and adapted to act between said friction elements at said opposite sides of said disc and said non-rotatable mounting therefor;

characterised by said method comprising:

g) the step of providing said resilient means adapted to act on both of said friction elements and to exert a differential spring effect as between one of said friction elements and the other thereof, by virtue of differential physical characteristics in the connection of said resilient means to said one and to said other of said friction elements, and causing same to exert such

differential spring effect.

2. A method of mounting a pair of friction elements in a disc brake comprising an axially slidable disc, the method comprising providing resilient means adapted to act between said friction elements and a non-rotatable mounting therefor, and causing said resilient means to apply a resilient bias between said brake friction elements and said non-rotatable mounting therefor, and causing said resilient bias to be applied to said friction elements in different magnitudes.

3. A method according to either one of the preceding claims characterised by the step of causing said resilient means to exert said differential spring effect by connecting same to said friction elements at a different spacing from said non-rotatable mounting for said friction elements on said one of said friction elements from said other.

4. A method according to any one of claims 1 to 3 characterised by causing said resilient means to exert said differential spring effect by connecting same to said friction elements at different locations on said resilient means at which said resilient means generates different levels of force.

5. A method according to claim 4 characterised by providing said resilient means comprising wire spring means and causing said wire spring means to exert said differential spring effect by virtue of shaped portions of the wire spring in which the wire follows a non-linear profile.

6. A method accordingly to any one of the preceding claims characterised by providing said resilient means comprising said wire spring means extending generally axially with respect to said brake disc between said friction elements and causing said wire spring to extend generally laterally with respect to said axial portion of the spring at the ends of the spring and causing one of said laterally extending ends to engage said non-rotatable mounting for said friction elements and the other of said laterally extending ends to extend across to and to be joined integrally to another similar wire spring structure forming therewith a generally U-shaped overall spring structure which cooperates with the friction elements at the opposite (circumferentially spaced with respect to the brake disc) sides of each friction element.

7. A spot-type automotive disc brake, the disc brake comprising:-

a) at least one rotatable brake disc;

b) a rotatable mounting for said brake disc to permit such rotation and which is adapted to drive said brake disc and to have exerted thereon a braking effect by said brake disc when the disc brake is actuated;

c)at least one pair of friction elements adapted to frictionally engage braking surfaces on opposite sides of said brake disc to effect braking on actuation of actuation means therefor;

d) said brake disc being axially slidable in use with respect to said mounting therefor under the action of said friction elements and said actuation means therefor during braking;

e) a non-rotatable mounting for said friction elements adapted to permit sliding movement of same into and out of frictional engagement with said disc while

resisting movement of same under the action of frictional forces generated by engagement of same with said discs

f) resilient means being provided in relation to said non-rotatable mounting and adapted to act between said friction elements at said opposite sides of said disc and said non-rotatable mounting therefor;

characterised by said disc brake further comprising:

g) providing said resilient means adapted to act on both of said friction elements and to exert a differential spring effect as between one of said friction elements and the other thereof, by virtue of differential physical characteristics in the connection of said resilient means to said one and to said other of said friction elements.

8. A disc brake comprising an axially slidable disc, and resilient means adapted to act between a pair of friction elements and a non-rotatable mounting therefor, said resilient means being adapted to apply a resilient bias between said brake friction elements and said non-rotatable mounting therefor, said resilient bias being applied to said friction elements in different magnitudes, in use.

9. For use in a method according to claim 1 or claim 2, the combination of a pair of brake friction elements and resilient means adapted exert a differential spring effect as between one of said friction elements and the other as aforesaid.

10. A brake according to claim 7 or claim 8 characterised by said resilient means being adapted to exert said differential spring effect by connecting same to said friction elements at a different location on said one of said friction elements from said other.

11. A brake according to claim 7 or claim 8 characterised by said resilient means being adapted to exert said differential spring effect by being connected to said friction elements at different locations on said resilient means.

12. A brake according to claim 11 characterised by said resilient means comprising wire spring means and said wire spring means being adapted to exert said differential spring effect by virtue of shaped portions of the wire spring in which the wire follows a non-linear profile.

13. A brake according to any one of claims 7, 8 and 10 to 12 characterised by said at least one rotatable brake disc being one of at least two slidably mounted brake discs, and said pair of sliding friction elements comprising a double-sided friction element located between said discs and a single-sided friction element located between one of said discs and said actuation means.

14. A method of mounting a friction element in a spot-type automotive disc brake substantially as described herein with reference to the accompanying drawings.

15. A disc brake substantially as described herein with reference to the accompanying drawings.

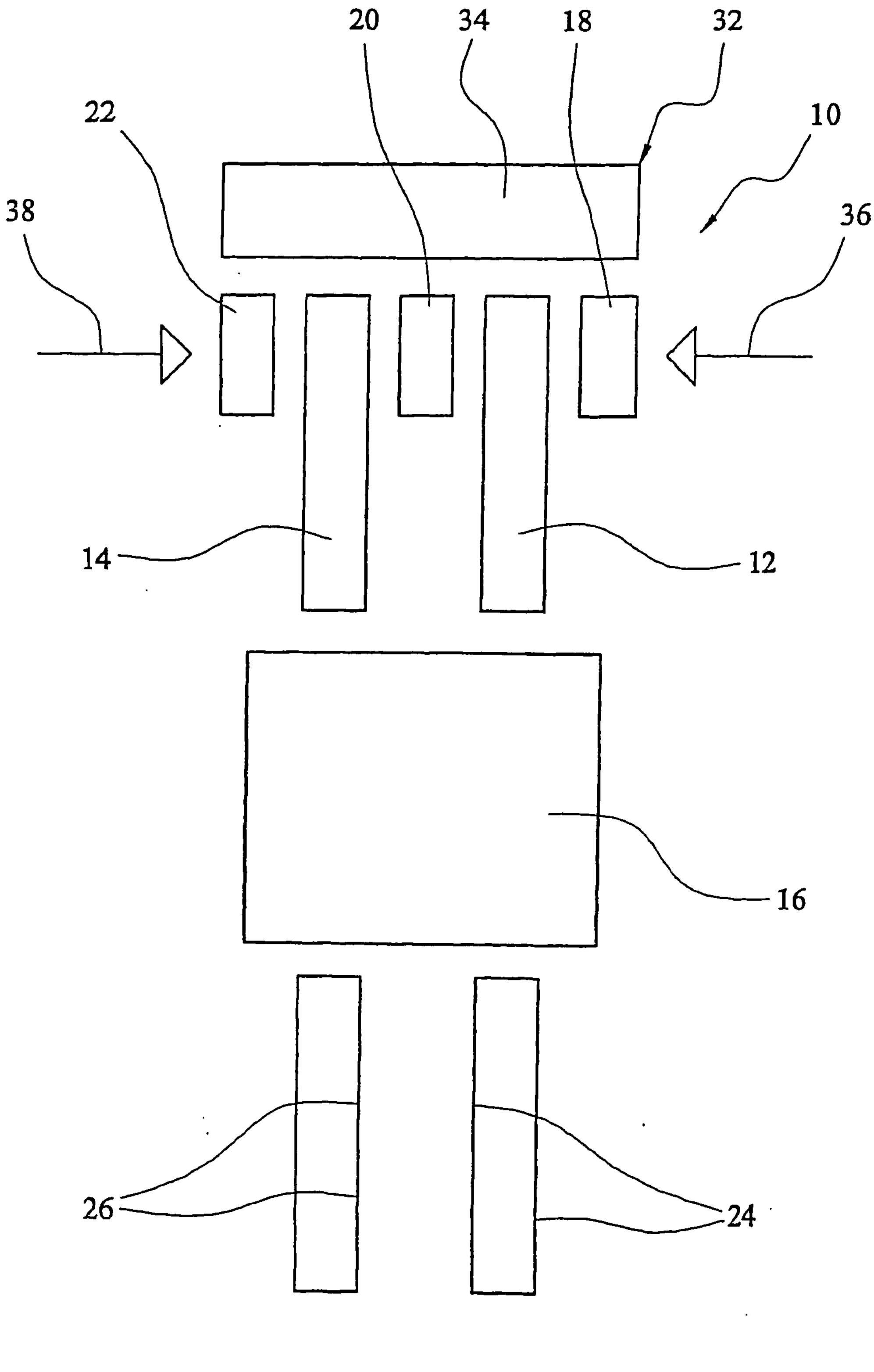


FIG. 1

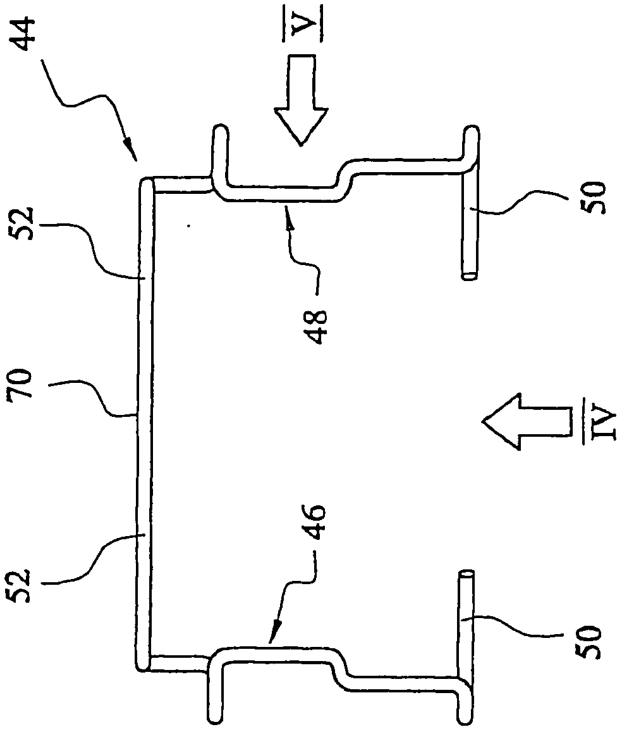


FIG. 3

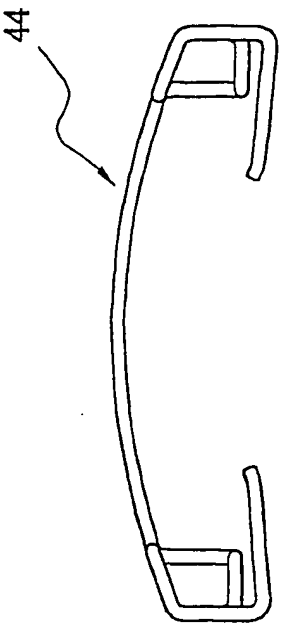


FIG. 4

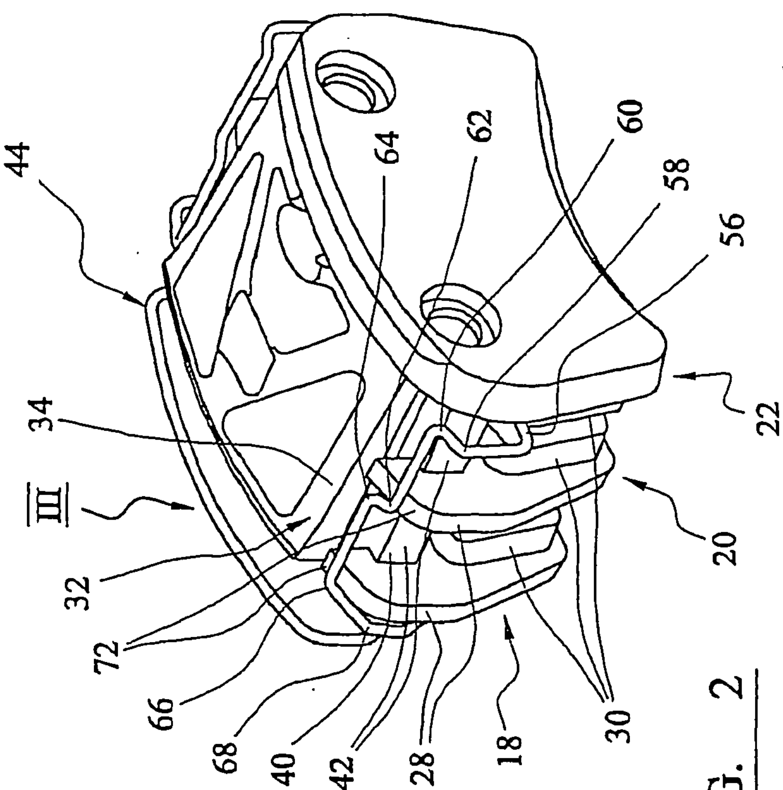


FIG. 2

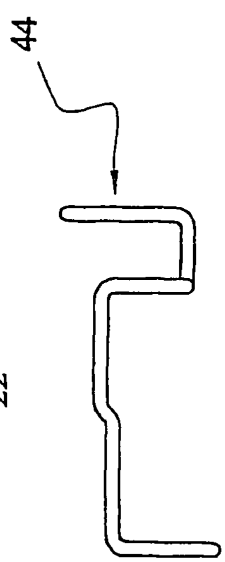


FIG. 5

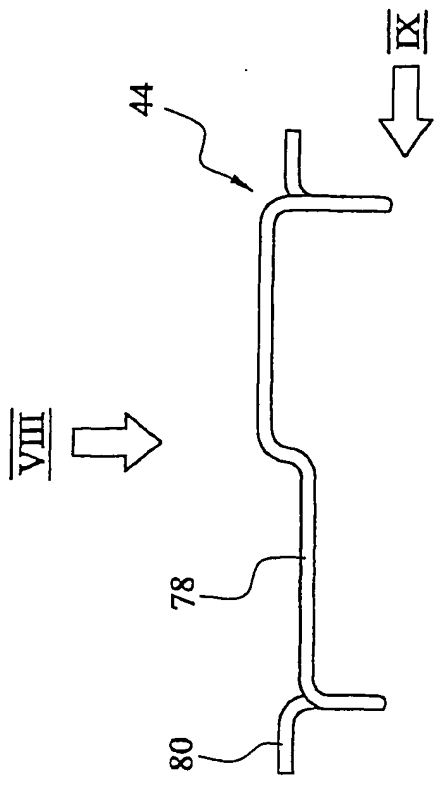


FIG. 7

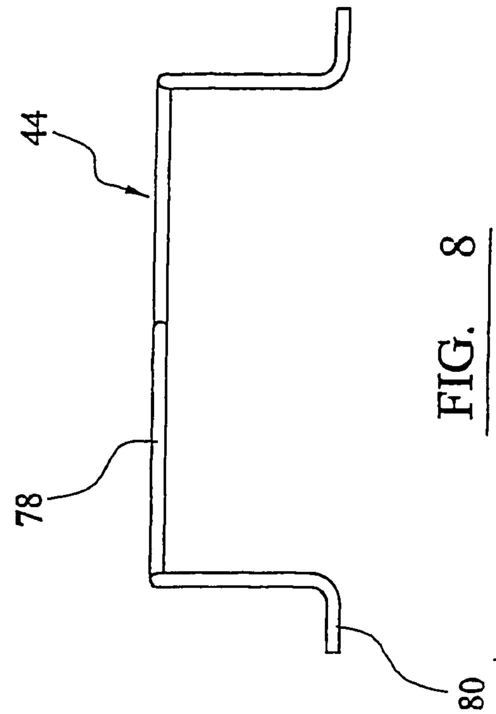


FIG. 8

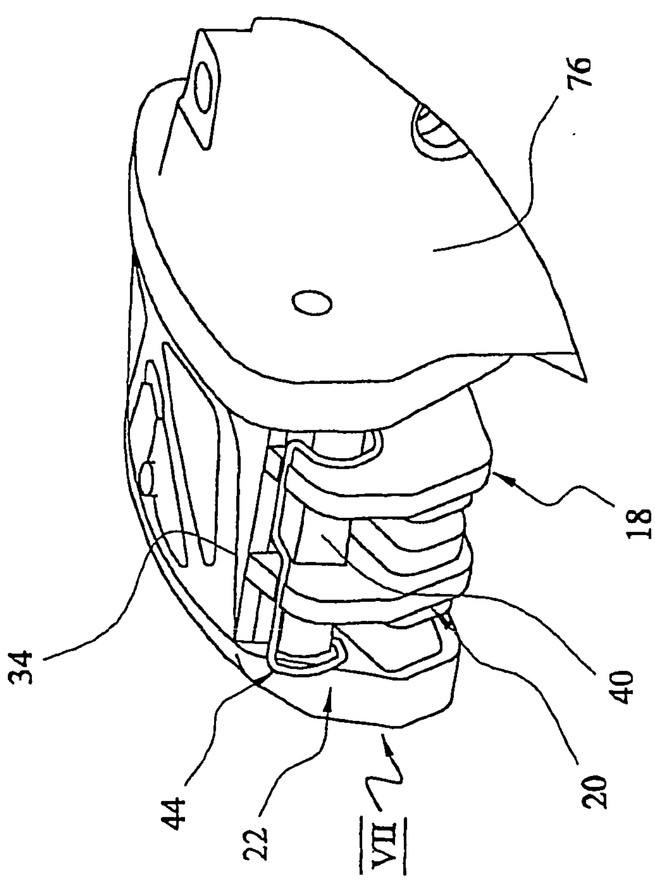


FIG. 6

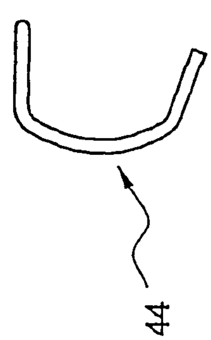


FIG. 9

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 01/01955

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16D65/097

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F16D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 98 25804 A (FEDREAL-MOGUL) 18 June 1998 (1998-06-18) cited in the application page 7 -page 8; figure 1	1,2,7-9
A	US 4 606 439 A (MEYNIER GUY ET AL) 19 August 1986 (1986-08-19) column 2, line 43 -column 3, line 50; figures 3,4	1,2,7-9
A	GB 2 258 701 A (GEN MOTORS FRANCE) 17 February 1993 (1993-02-17) page 6, line 14 -page 8, line 7; figures 3,5	1,2,7-9

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
20 August 2001	27/08/2001

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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